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(54) Gas turbine casing

(57) A containment ring 22 surrounding the blades of a ducted fan gas turbine engine comprises a rigid cylinder 23 around which are wound layers of woven fibrous material 26*a*, *b*, *c*, which may be covered with a further impervious layer.

Layers of woven material (KEVLAR) with a protective shield

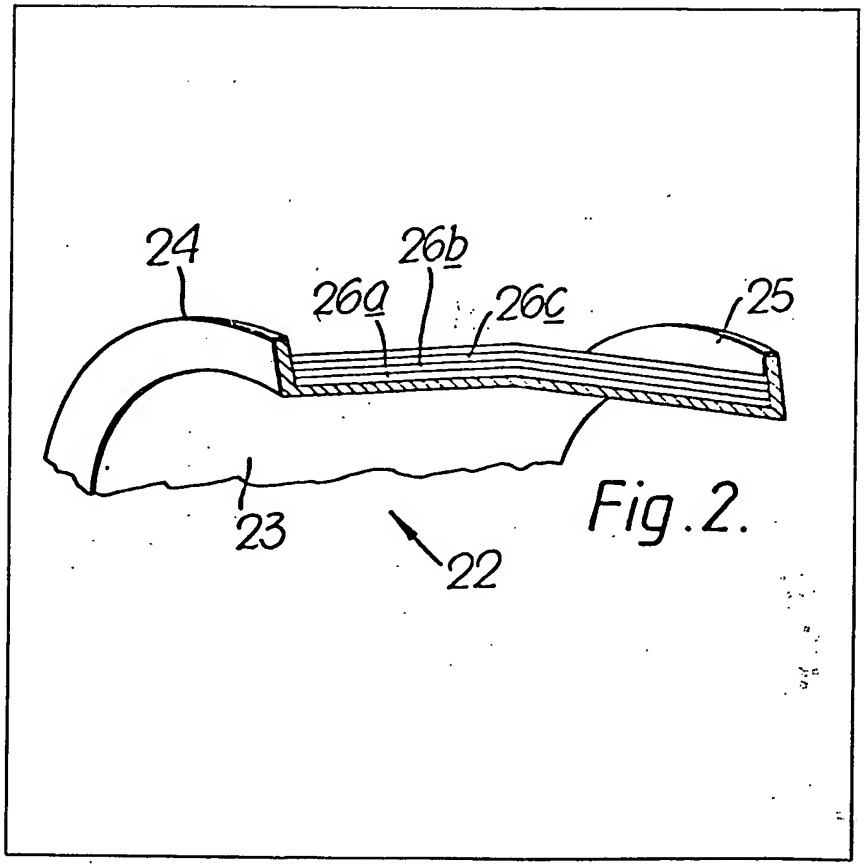

Fig. 2.

The drawing originally filed was informal and the print here reproduced is taken from a later filed formal copy.

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Fig.1.

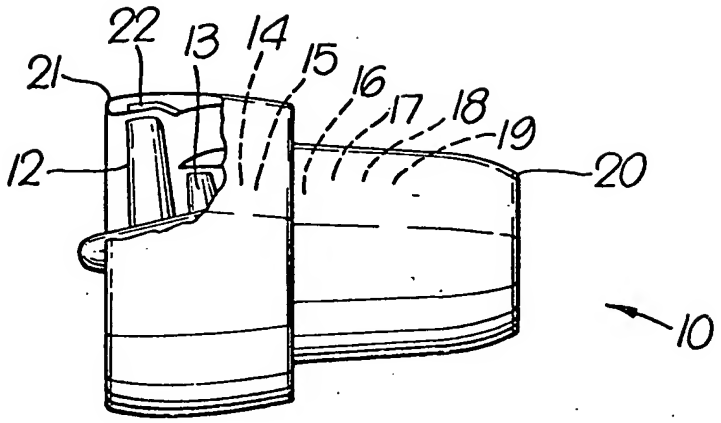
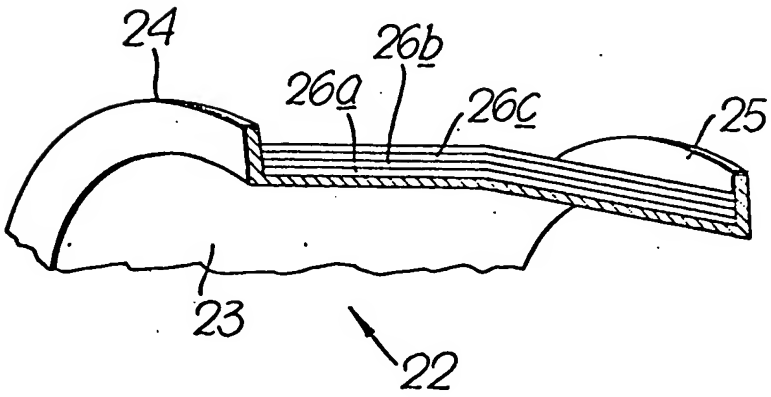


Fig.2.



SPECIFICATION

Gas turbine casing

This invention relates to a gas turbine engine casing and more particularly to an improved containment ring for use within or forming an integral part of the fan duct casing of a gas turbine engine.

The use of containment rings in gas turbine engines has been known for many years. It is necessary to provide containment rings such that in the event of a blade or other rotating part of the engine becoming detached, such parts or blades will be prevented from passing through the engine casing by means of the containment ring, thus reducing the possibility of damage to the remainder of the aircraft or engine structure.

Containment rings have in the past been manufactured from metal or alternatively resin impregnated glass fibre or carbon fibre etc., and have usually formed an integral part of the compressor casing. Such rings have suffered several disadvantages in particular metal rings have to be manufactured from relatively thick section material to ensure that they have adequate strength, this obviously results in a heavy structure which is particularly undesirable in the case of an aircraft gas turbine engine. Obviously composite material containment rings are much lighter than metal ones, however because of the presence of the resin, energy absorption has been confined to a localised area around the impact point with the result that only a small part of the fibres of the ring actually takes the strain.

An object of the present invention is to provide a containment ring for a gas turbine engine in which the aforementioned disadvantages are substantially eliminated.

According to the present invention a containment ring for a gas turbine engine comprises a substantially rigid cylinder around the periphery of which are wound a plurality of layers of fibrous material. Furthermore the layers may be secured to each other by suitable fixing means such as for example stitching or weaving.

Alternatively the at least last two layers of the plurality of layers are secured to each other by means of a plurality of pins, which pins are attached to a common backing sheet.

Preferably the fibrous material consists of an aromatic polyamide fibre woven into an elongate tape.

Alternatively the fibre may comprise glass fibre, carbon fibre or metallic fibre which is woven into suitable tape.

Preferably the substantially rigid cylinder comprises a relatively thin section lightweight metal structure or alternatively it may be manufactured from a fibre reinforced resin composite material.

According to a further aspect of the invention the plurality of layers of woven fibrous material are covered with an impervious layer of material, which impervious layer may comprise a resin layer or alternatively a metallic or non-metallic skin.

For better understanding of the invention an embodiment thereof will be more particularly described by way of example only and with reference to the accompanying drawings in which:—

Figure 1 shows a diagrammatic view of a ducted fan type gas turbine having a broken away casing portion disclosing a diagrammatic view of an embodiment of the present invention.

Figure 2 shows an enlarged and more detailed view of the embodiment of the invention shown diagrammatically at Figure 1.

Referring to the drawings the ducted fan type gas turbine engine shown generally at 10 comprises in flow series a fan 12, an intermediate pressure compressor 14, a high pressure compressor 15, combustion equipment 16, and high, intermediate and low pressure turbines indicated at 17, 18 and 19 respectively, the engine terminating in an exhaust nozzle 20.

Provided radially outwardly of the fan 12 is located a fan duct 21 which is connected to the remainder of the engine by radially extending struts not shown in the drawings. Within the fan duct 21 is provided a containment ring 22 arranged radially outwardly of the fan 12, the ring being located such that in the event of a blade or disc failure the broken blade or disc portion or portions will be contained within the engine casing or alternatively the energy of the portion will be reduced to an acceptable level.

The containment ring shown generally at 22 comprises a relatively thin section substantially rigid cylinder 23 including flanged ends 24 and 25. The cylinder 22 may be manufactured from metal such as for example stainless steel, nickel alloy, or alternatively a fibre reinforced resin composite structure which may be manufactured by any of the well known weaving or winding or knitting techniques.

A plurality of layers 25*a*, 25*b*, 26*c*, etc. of woven, wound or knitted material are wound around the outer periphery of the cylinder 25 and the layers may then be secured together to maintain them in a preferred location by either stitching or weaving or some other suitable fixing means. Alternatively the fixing means may comprise a plurality of pins which are each secured to a common backing member. This may be located upon the partially wound casing prior to the last two turns of material. The pins will then protude through the final layers of wound material and may then be bent over to hold the final layers in place. The layers of material comprising a continuous length of tape which in the preferred embodiment of the invention is woven or knitted from an aromatic polamide fibre. The fibre which appears most suitable for the present purposes is that made by Du Pont Limited and sold under the Registered Trademark KEVLAR.

During the development of the present invention several tests were made on scale models of containment rings made both in accordance with the previously described embodiment of the present invention, and several other rings were also tested which were made from a variety of other materials.

All the test pieces were in the form of an $8\frac{1}{2}$ inch diameter cylinder with variations in material thickness and with additional windings of tapes, some of which included resins.

All the tests were carried out using a $6\frac{1}{2}$ gram, 9.57 mm. diameter hollow steel missile. The missiles were fired from a compressed gas gub such that the trajectory of the missile was at 60° to the tangent on the test ring at the point of impact. Tests were performed at varying impact velocities by varying the gas gun pressure and all the impacts were recorded on a high speed cine film. Missile speeds were recorded by fitting two pre-stretched wires across the end of the gun barrel at a set distance apart and measuring electronically the time interval taken to break the wires.

Set out below are a list of the test results which are self explanatory.

TEST ASSEMBLY		MISSILE ENERGIES IN FOOT POUNDS	
Containment Ring	Additional Winding	Maximum Contained	Minimum Not Contained
Stainless Steel .045 Ins. Thick	None	234	229
Nickel Based Alloy .045 Ins. Thick	None	209	213
Stainless Steel .022 Ins. Thick	None	23	18
Stainless Steel .022 Ins. Thick	Carbon Fibre with I.P.D.	113	116
"	E Glass Filament with I.P.D.	188	190
Stainless Steel .022 Ins. Thick	E Glass Filament with D.D.S.	192	190
"	E Glass Filament with Polyurethane	124	135
"	Glass Cloth with I.P.D.	–	<115
"	Glass Cloth with Alternate Windings of E Glass Filament	135	148
"	Kevlar 49 Filament with I.P.D.	137	137
"	Kevlar 29 Filament with I.P.D.	216	227
"	Kevlar 49 Tape .75 Ins. Wide × 9 Turns	234	–
"	Kevlar 49 Tape .75 Ins. Wide × 4 Turns	238	–
"	Kevlar 29 Tape .75 Ins. Wide × 4 Turns	240	–

Abbreviations Key

Kevlar 29 – High Strength Intermediate Modulus Fibre

Kevlar 49 – High Strength High Modulus Fibre

I.P.D. – Isophorone-diamine

D.D.S. – Diamine Diphenyl Sulphone

As will be seen from the table of results, the tests show that rings manufactured from relatively thin section metal upon which are wound layers of KEVLAR tape, have the ability to withstand much greater impacts than those manufactured from other materials.

It is believed that one of the main reasons why this type of construction is stronger than other types is because it has the ability to transmit the shock of an impact over a much greater area of the structure than in the other types. This is because the layers of tape may move relative to each other, thus transmitting the loading, such that it is transmitted through a major portion of the structure and is thus absorbed by the elasticity of the KEVLAR.

CLAIMS

1. A containment ring for a gas turbine engine comprising a substantially rigid cylinder around the periphery of which are wound a plurality of layers of fibrous material.

2. A containment ring as claimed in claim 1 in which the plurality of layers are secured to each other by stitching or weaving.

3. A containment ring as claimed in claim 1 in which at least the last two of the plurality of layers are secured to each other by means of a plurality of pins which pins are attached to a common backing sheet.

4. A containment ring as claimed in claim 1 in which the layers of fibrous material consist of an aromatic polyamide fibre woven into an elongate tape.

5. A containment ring as claimed in claim 1 in which the layers of fibrous material may consist of glass fibre, carbon fibre or metallic fibre woven into tape.

6. A containment ring as claimed in claim 1 in which the rigid cylinder comprises a relatively thin section lightweight metal structure.

7. A containment ring as claimed in claim 1 in which the rigid cylinder is manufactured from a fibre reinforced resin composite material.

8. A containment ring as claimed in any preceding claim in which the plurality of layers of woven fibrous material are covered with an impervious layer of material.

9. A containment ring as claimed in claim 8 on which the impervious layer may comprise a resin layer or alternatively a metallic or non-metallic skin.

10. A containment ring suitable for use within the fan sheet of a ducted fan type gas turbine engine.

11. A containment ring for a gas turbine engine as claimed in any preceding claim substantially as hereinbefore described by way of example only and with reference to the accompanying drawings.

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